10/579283

IAP20 Rec'd PCT/PTO 15 MAY 2006

SPECIFICATION

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ARTICULATED ARM TRANSPORT APPARATUS

Description

The invention relates to a transport apparatus for transporting workpieces from one machining station to the subsequent machining station of a press, press line, simulator, or the like, in accordance with the preamble to claim 1.

Prior art

Where the manufacture of a workpiece calls for a plurality of work operations, such as cutting or shaping, then for economic production the necessary individual operations are carried out in a transfer press or press line, as they are known. The number of tools then corresponds to the number of work stages that are necessary for the manufacture. In the presses there are transport devices with which the workpieces are transported from one workstation to the next.

In the case of transfer presses or large-component transfer presses, the transport devices comprise gripper or load-bearing rails that extend through the entire length of the shaping machine. In order to transport the workpieces, the load-bearing rails are fitted with gripper or holding elements. In this case, a distinction is made, depending on the movement sequence, between a two-axis transfer fitted with suction crossmembers or a three-axis transfer fitted with gripper elements. As an additional movement, pivoting in order to change the attitude of the component during the transport step may be required. This attitude change can also occur using an orientation station arranged between the shaping stages.

The transfer movement is initiated via cams that are forcibly synchronized with the ram drive via movement transmission elements. The manufacture of large-area

components, in particular, has led to the development of large-component transfer presses of greater and greater dimensions, based on the shaping force and the transport paths. Tool spacings on the order of magnitude of 5000 mm are entirely normal nowadays, and therefore corresponding transport steps are also necessary.

As a result of this development, the masses to be accelerated and braked in the transfer systems are completely opposed to the low masses of the components to be transported. Since the transport step is to be executed in an extremely short time, in order to achieve the greatest possible number of press strokes and therefore output of components, the system must have a high speed and therefore also acceleration and retardation.

A further disadvantage is the rigid movement sequence which is predefined by the cam drives. The optimum utilization of the free spaces between the lower and upper tool during the ram stroke to transport the parts is not possible.

In order to avoid these indicated disadvantages, current new developments concern replacing the previous transfer system with a corresponding number of transfer systems arranged between the machining stages and equipped with discrete drives. Such an arrangement is disclosed in EP 0 672 480 B1. Transfer systems arranged on the uprights are equipped with a number of drives that, mechanically linked to the movement transmission means, transport the components. As a special feature, the system can be re-equipped both as a two-axis transfer with suction beams and as a three-axis transfer with grippers. However, this universal use requires corresponding structural complexity.

A transfer device disclosed in DE 100 42 991 A1 is also arranged in each upright

area. The transport apparatus is embodied as an articulated arm and is thus designed such that favorable clearances are possible relative to the ram movement. The articulated arm can thus move between upper and lower tool with a relatively small opening stroke of the press ram carrying the upper tool for removing the part.

Disadvantageous in this arrangement is the space required for avoiding a collision between the ram and the transfer apparatus. In the prior art, a free space is required between the upright and the ram so that the transport apparatus can execute the pivot movement. This leads to pressing the larger dimensions transverse to the part transport direction required.

Object and advantage of the invention

The object of the invention is to further develop an articulated arm transport apparatus such that no additional space is required for the articulated arm transport apparatus between the upright and the ram.

The basic idea behind the invention is to modify the movement sequence of the articulated arm transport apparatus such that an adequate, in particular vertical, distance to the ram is provided. The geometry of the articulated arm parts is also changed and it is no longer executed in the same length, but rather the front articulated arm part to which the transverse crossmember is attached to the parts holding means is suggested shorter, which further improves the clearance. In addition, the articulated arm transport apparatus has an advantageous effect in the upright area and above the workpiece transport plane.

The articulated arm transport apparatus is mounted to the press uprights above the

component transport plane. The first articulated arm part is dimensioned such that overlapping with the ram is not possible until there is a relatively large pivoting angle. Due to the ram movement, it is then situated in the area of its upper dead center, however, which reliably prevents a collision. The forward articulated arm part performs a pivoting movement directed upward relative to the point of rotation of the articulated arm parts. The first articulated arm part is pivotably borne on a carriage for performing a vertical lifting movement during the workpiece transport. The overlapping movement of the two articulated arm parts in connection with the vertical lift axis enables a freely programmable travel curve profile in a large band width, both for the component transport and for the unproductive movement. The unproductive movement can thus realize a very flat and therefore, relative to the clearance, extremely favorable travel curve. Thus it is possible to move the articulated arm into the free space that forms between upper and lower tool in an advantageous manner with a relatively small opening stroke of the press ram. The sequence results in less time for the component transport and leads to an increase in the press system's efficiency. Because of the dynamic lift axis, the articulated arm apparatus can be operated without additional structural measures, even at very different tool heights.

The entire transport apparatus comprises two articulated arm transport apparatuses that are arranged in the upright area in a mirror-image of one another and that are joined to one another via a transverse crossmember. The transverse crossmember is coupled to the front end of the shorter articulated arm part and carries the actual holding means for workpieces. Corresponding to the required functionality, the transverse crossmember can be provided additional degrees of freedom, such as pivoting in or counter to the direction of transport, an inclined position, or the ability of the holding means to traverse transverse to the part direction of

transport, e.g. for dual parts. Each of the functions can be accomplished with a discrete drive on the transverse crossmember or by means of stationary drives via the articulated arm.

During the actual shaping process, the articulated arm transport apparatus is situated in a parked position in the upright area. The suggested design indicates a very favorable, narrow structure that is advantageous for the configuration of the press uprights. The latter can be dimensioned exclusively according to the teaching of strength and do not require any additional width for the transport apparatus.

The movement transmission from the first to the second articulated arm part is accomplished via a fixed transmission. This enables a transmission adapted to the shaping stages and to the different tools, and thus enables a travel curve that is smooth and optimized in terms of movement.

Additional details and advantages of the invention result from the following description of an exemplary embodiment.

Figure 1 illustrates the transfer press with articulated arm transport apparatus

Figure 2 is a detail of the drive for the articulated arm transport apparatus

Figure 3 is as for Figure 2, but in a sectional representation

Description of the exemplary embodiment

By way of example, Figure 1 provides a segment of a transfer press 1. The headpiece 2 can be seen, as can the ram 3 with the upper tool 4 attached thereto.

The lower tool 5 is clamped to the press table or sliding table 6. The inventive articulated arm transport apparatus 11 – 14 is attached to the press uprights 7 through 10 and depicted in different functions. The articulated arm transport apparatus 11 arranged on the press upright 7 illustrates removal of the shaped workpiece. The transport apparatus 12 allocated to press upright 8 is in the parked position during the shaping process. The transport apparatus 13 has removed a workpiece and is transporting the latter along the travel curve 15 to the next shaping step. Finally, the articulated arm transport apparatus 14 is placing the workpiece into a lower tool 5.

The arrangement of the articulated arm transport apparatus can be easily seen and is particularly advantageous for using the clearance between upper and lower tools. The movements of the transport apparatus do not interfere with the ram movement at all and thus the press does not have to be expanded to create a free space for the transport apparatus.

The travel curves 15 and 16 provide a visual illustration of the favorable relationships for very flat insertion, removal, and placement of the workpieces. The travel curve 16 illustrates the movement of the articulated arm without a workpiece. The travel curve 15 illustrates workpiece transport.

The articulated transport apparatus are each arranged on the press uprights by pair and in mirror image. The apparatus are joined via a transverse crossmember 17 to which the workpiece holding means 18 are attached.

Figure 2 provides a front elevation of the articulated arm transport apparatus. It comprises the articulated arm parts 19 and 20. Two drives 21 and 22 are provided

for driving the two articulated arm parts, and they cause the toothed wheels 23 and 24 to rotate or keep them in a home position. These toothed wheels 23 and 24 act on the racks 25 and 26 such that the latter perform a corresponding vertical movement.

The parts of the racks 25 and 26 that are oriented downward act in concert on the toothed wheel 27. The articulated arm 19 is securely connected to a common center point of movement 28 with this toothed wheel 27.

The movement sequences for the articulated arm 19 can be seen in the table 46. However, the only movements illustrated are those that result, when driven, using the same number of rotations for the drives 21 and 22. For instance, when both drives 21 and 22 rotate to the right for the same number of rotations, this causes a rotation of the toothed wheel 27 to the right via the drive train 23, 24, 25, 26 and thus also a pivoting movement to the right by the articulated arm 19 connected to the toothed wheel 27. In this case, no movement takes place in the vertical (Y-) axis. Overlapping movement, i.e., pivoting and vertical movement, is attained e.g. when the drive 21 idles and the drive 22 rotates. As can be seen from the table 46, any desired travel curve in a plane can be attained using the appropriate rotation or idling of only the drives 21 and 22. Large transport paths can be executed with no problem with the suggested articulated arm transport apparatus. The identical movement sequences can also naturally be attained with other drive components. For instance, if the toothed wheels 23 and 24 and the racks 25 and 26 are replaced with separately driven toothed belts with corresponding toothed belt pulleys, the exact same movements can be traveled.

Figure 3 illustrates how the first articulated arm part 19 forwards the pivoting movement to the second articulated arm part 20. The toothed wheel 30, which is situated in the first articulated arm part 19, is connected to the carriage 29 via the axis 45. The toothed wheel 30 is mechanically linked to the toothed wheels 31 through 34. The toothed wheel 34 is securely joined to the second articulated arm part 20. If a pivoting movement of the first articulated arm part 19 is introduced via the drive chain 23, 24, 25, 26, this generates a rolling rotational movement of the toothed wheels 31, 32, 33, 34 and, due to the secure connection to the toothed wheel 34, the corresponding pivoting of the second articulated arm 20 about the axis of rotation 35.

For the pivoting movement of the transverse crossmember 17 about the axis 38, a pinion gear 39 attached to the drive 36 drives the toothed wheel 40, which forwards the movement to the bevel gears 41 through 44.

Drive 37 can perform a potentially necessary moving apart of the workpiece holding means 18 for dual parts via a second system of bevel gears that are borne in the hollow shafts of the bevel gears 41 through 43 for the pivoting.

The invention is not limited to the described and illustrated exemplary embodiment. It also includes all pertinent designs in the framework of the valid claim 1.

Legend

1	Transfer press	24	Toothed wheel
2	Headpiece	25	Rack
3	Ram	26	Rack
4	Upper tool	27	Toothed wheel
5	Lower tool	28	Point of rotation
6	Sliding table	29	Carriage
7	Press upright	30	Toothed wheel
8	Press upright	31	Toothed wheel
9	Press upright	32	Toothed wheel
10	Press upright	33	Toothed wheel
11	Articulated arm transport apparatus	34	Toothed wheel
12	Articulated arm transport apparatus	35	Point of rotation
13	Articulated arm transport apparatus	36	Drive
14	Articulated arm transport apparatus	37	Drive
15	Travel curve with workpiece	38	Axis of rotation
16	Travel curve without workpiece	39	Toothed wheel
17	Transverse crossmember	40	Toothed wheel
18	Workpiece holding means	41	Bevel gear
19	Articulated arm part	42	Bevel gear
20	Articulated arm part	43	Bevel gear
21	Drive	44	Bevel gear
22	Drive	45	Axis
23	Toothed wheel	46	Movement table
		47	Pivoting angle
		48	Pivoting angle